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Enhance the voltage drop in the end costumer of PT. PLN ULP 50 Kota using insertion transformer

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ABSTRACT

Loading that exceeds the capacity of the transformer if left unchecked will damage the transformer itself; apart from that, it can also cause drop voltage along the conductor, which causes electricity services to customers to be disrupted, especially at the customer end. The results of research at PT PLN (Persero) ULP 50 Kota Suliki Service Office revealed that of the 108 existing transformers, the GD 175 Kasiak Rampung transformer experienced overload with a percentage of 99%, and the end voltage measurement was 177 volts. This figure does not comply with the standards set by PLN. An insert transformer was built as an improvement effort so that the loading percentage decreased to 45% and the end voltage became 277 volts. This effort provides benefits, namely improving the quality of customer service, increasing electricity sales, reducing ENS if there are maintenance efforts, and improving the company's image.

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1. INTRODUCTION

Electricity is one of the infrastructure facilities that is very much needed in people's lives. Along with economic growth in Indonesia, the need and service for electrical energy has increased from year to year, both in terms of the number of customers and in terms of the electrical energy needed [1]. The distribution of electricity in the field often has problems, one of which is the loading of distribution transformers that has exceeded capacity or can be said to be overloaded transformers [2]-[5]. Overloading might harm the transformer if it continues for an extended period of time. Furthermore, voltage drops along the conductors it passes through can also result from overloaded distribution transformers [6]-[8]. While the impact of this disruption has a negative effect on customer service [9]-[16]. Furthermore, transformers that have a large capacity but are too little loaded cause PT PLN, as a provider of electricity services, to face economic losses, where transformers with large capacities should be able to be used to bear large loads.

According to preliminary data and findings from field observations, overloading and drop voltage at the customer end voltage were frequent issues even in the PT PLN ULP 50 Kota area. According to preliminary data collected at PT PLN ULP 50 Kota, 11 transformers in the work area faced overload during the first semester of 2023. This undoubtedly needs to be handled quickly to prevent issues with the transformer and to avoid interfering with client service.

This study focuses on optimizing the distribution transformer voltage while minimizing the voltage drops that often occur on the customer side of PT PLN (Persero) ULP 50 Kota. Consumers of PT. PLN ULP 50 Kota who are far from the distribution substation tend to receive lower voltages than in areas close to the distribution substation. In this study, the author focuses on analyzing transformer problems in the Suliki Service Office work area. This is because the two feeders under the auspices of the Suliki Service Office, namely the Andiang feeder and the Suliki feeder, have a fairly large work area. In addition, in this service area there were also five customer complaints regarding low voltage at KP Suliki in May 2023.

2. METHOD

This study is a descriptive qualitative investigation. The goal of this study is to optimize distribution transformer voltage while reducing frequent customer-side voltage decreases. The information gathered is predicated on field measurements and observations of the objects under study in order to examine situations firsthand. The study was carried out at PT. PLN 50 Kota between May and July 2024, namely in the KP Suliki Service Office workspace. After the data was examined using formulae and calculations to produce study findings that met needs, efforts were made to enhance. After the repairs were completed, a comparative percentage analysis was conducted to determine whether or not it had complied with the relevant standards.

A transformer is an electrical device that uses a magnetic coupling and the electromagnetic induction principle to transfer and convert electrical energy from one or more electrical circuits to another circuit with the same frequency and a specific transformation ratio. The voltage ratio between the primary and secondary sides is directly proportional to the number of turns and inversely proportional to the current ratio [17]. Transformers serve as crucial power distributors in electrical systems that include generation, transmission, distribution, and consumption by adjusting the voltage. The efficiency, voltage regulation, and load current flow of this transformer all demonstrate its operational performance. And how, in both regular and emergency situations, the transformer can keep running in the system [18]. Distribution transformers can be identified by the location of their installation as well as the insulation and cooling techniques employed. Distribution transformers are often separated into two major categories: liquid-filled distribution transformers and dry-type distribution transformers, depending on the insulation and cooling techniques employed. Distribution transformers can also be separated into two categories according to where they are located: distribution transformers put in poles and distribution transformers installed in substations [16].

Insertion transformer is an additional transformer installed by PT PLN to overcome various losses caused by the previous transformer. The difference between an insertion transformer and a new installation transformer is that an insertion transformer only takes the load of the previous transformer, while a new installation transformer is installing a new transformer because of a new request or replacement of a transformer because it is damaged, or because the transformer capacity is increased [19]. Distribution transformers are attempted not to be loaded more than 80% or below 40%. If it exceeds or is less than that value, the transformer can be said to be overloaded or underloaded. Furthermore, the impact of voltage drop on the customer side at the end of the load can be avoided [20]. The average current of the transformer load I_{avg}, the full load current I_{FL} and the percentage of transformer loading can use the formula:

$$I_{avg} = \frac{I_R + I_S + I_T}{3} \tag{1}$$

$$I_{FL} = \frac{P_{tr}}{V \times \sqrt{3}} \tag{2}$$

$$\%\ Loading = \frac{I_{avg}}{I_{FL}} \times 100\% \tag{3}$$

$$P_{tr} = V \times I \times \cos\varphi \tag{4}$$

where I_R, I_S, I_T are the current of R phase, S phase and T phase, respectively. P_{tr} is the power rating of transformer. Voltage drop is the amount of voltage lost in a conductor. The disturbance occurs because of the length of a conductor in a medium voltage distribution line. Voltage drop is generally the voltage used on the load. Voltage drop is caused by the current flowing through the wire resistance. Voltage drop V on the conductor is greater if the current I in the conductor is greater and if the conductor resistance Rℓ is also greater [3]. Based on PLN regulations, one of the requirements for system reliability is that the voltage drop on the customer side must not be more than +5% -10% of its normal voltage [20].

3. RESULTS AND DISCUSSION

PT PLN (Persero) ULP 50 Kota is a unit of PT PLN (Persero) UP3 Payakumbuh which has 8 Service Offices. Internally, operations at ULP 50 Kota are focused on Operation and Maintenance (O&M) activities and K3 (Occupational Safety and Health). Based on data obtained at PT PLN (Persero) ULP 50 Kota, it is known that in the Suliki Service Office (KP) work area, namely the Suliki and Andiang feeders, there are 108 transformers. Transformer data is obtained from field measurements. then the data is processed using formulas (1) to (4) to obtain the percentage of loading. Table 1 describes the calculation results.

Table 1. Transformer loading percentage

No	Substation Code	Address	Feeder	Average current (Ampere)	IFL (Ampere)	Loading (%)
1	GD 175	Kasiak Rampung	Suliki	37,0	37,2	99,3
2	GD 142	Koto Tinggi Mahat	Anding	54,3	72,1	75,4
3	GD 122	Tanjuang Bungo	Suliki	51,7	69,5	74,4
4	GD 165	Pauh	Anding	53,7	72,1	74,5
5	GD 140	Tanjung Sakato	Anding	54,0	73,7	73,2
6	GD 156	Kt Marapak Banjar Lawas	Anding	16,7	22,8	73,0
7	GD 133	Talang Anau	Suliki	50,3	69,5	72,4
8	GD 392	Ssp Koto Tinggi	Suliki	51,3	72,3	71,0
9	GD 131	Ikan Banyak	Suliki	49,3	72,6	67,9
10	GD 177	Jorong Batung	Suliki	23,7	34,8	68,0
11	GD 123	Batang Linjuang	Suliki	23,3	30,0	77,7
12	GD 245	Ssp Baruh Gunung	Anding	46,3	71,0	65,2
13	GD 118	Suliki	Suliki	144,3	220,7	65,4
14	GD 149	Sei Dadok	Suliki	47,3	75,7	62,6
15	GD 154	Bukit Bulat	Anding	22,7	35,7	63,5
16	GD 446	Sisipan Bukit Apit	Anding	45,3	71,7	63,2
17	GD 121	Lancaran	Suliki	22,0	35,8	61,5
18	GD 119	Batu Bauak	Suliki	21,0	35,1	59,9
19	GD 158	Koto Tangah	Anding	88,0	145,6	60,4
20	GD 151	Anding	Anding	86,0	141,7	60,7
21	GD 428	Ampang Gadang 3	Anding	22,0	37,1	59,2
22	GD 186	Rm Gadang Anding	Anding	42,7	74,7	57,1
23	GD 254	Ssp Kt Tinggi Mahat	Anding	41,7	71,9	58,0
24	GD 228	Ssp Anding	Anding	82,7	144,9	57,1
25	GD 159	Sei Naning	Anding	41,3	72,3	57,2
26	GD 178	Talang Kijang	Anding	41,3	75,3	54,9
27	GD 424	Kampung Padang	Suliki	20,3	36,8	55,3
28	GD 148	Puar Datar	Suliki	41,0	74,7	54,9
29	GD 443	Asam Panjang	Suliki	39,3	72,6	54,2
30	GD 138	Koto Tinggi 1	Anding	38,0	70,5	53,9
31	GD 247	Ssp Ronah	Anding	39,7	73,7	53,8
32	GD 152	Guntung	Anding	78,0	147,1	53,0
33	GD 153	Jambak	Anding	37,0	69,8	53,0
34	GD 383	Ampang Gadang 1	Anding	19,0	36,8	51,7
35	GD 134	Koto Marapak	Suliki	36,7	71,2	51,5
36	GD 162	Pamatang Aur	Anding	36,0	70,8	50,8
37	GD 171	Luak Begak	Suliki	18,3	36,5	50,2
38	GD 129	Koto Panjang	Suliki	36,7	73,2	50,1
39	GD 176	Sei Mangkirai	Suliki	35,7	71,2	50,1
40	GD 460	Andiang Mudiak	Anding	36,3	73,4	49,5
41	GD 155	Bannjar Lawas Kecil	Anding	35,7	72,1	49,5
42	GD 220	Pagadih	Suliki	36,3	73,9	49,2
43	GD 112	Kampung Dalam	Suliki	70,3	150,5	46,7
44	GD 391	Ssp Banja Laweh	Anding	33,3	71,2	46,8
45	GD 401	Kubu Baru Baruah Gng	Anding	33,0	71,0	46,5
46	GD 246	Ssp Bg Tanjung	Anding	34,0	74,1	45,9
47	GD 445	Sopan Tanah	Anding	31,7	71,5	44,3
48	GD 144	Sopan Gadang	Anding	32,7	74,1	44,1
49	GD 116	Lombah	Suliki	31,3	72,8	43,0
50	GD 128	Mudiak Liki	Suliki	32,0	73,9	43,3
51	GD 137	Koto Tinggi	Suliki	60,0	140,3	42,8
52	GD 231	Spp Sei Sirih	Suliki	31,3	73,7	42,5
53	GD 500	Banda Raik	Anding	29,7	70,5	42,1
54	GD 164	Baruh Gunung 2	Anding	59,3	143,1	41,5
55	GD 124	Ateh Koto	Suliki	14,0	34,4	40,7
56	GD 150	Air Hangat	Suliki	30,3	74,9	40,5
57	GD 187	Labuah Timbun	Suliki	14,7	37,2	39,4
58	GD 420	Mahat	Anding	28,7	74,5	38,5
59	GD 145	Lakung	Suliki	28,3	73,7	38,4
60	GD 125	Padang Laweh	Suliki	13,0	36,3	35,8
61	GD 157	Paninjauan	Anding	24,7	65,1	37,9
62	GD 423	Datar Koto Tangah	Anding	27,0	71,4	37,8
63	GD 505	Tabek Kongsi	Suliki	26,3	71,7	36,7
64	GD 126	Suliki Baruah	Suliki	26,3	73,0	36,1
65	GD 160	Apar	Anding	25,0	69,0	36,2
66	GD 130	Kampung Patai	Suliki	26,3	73,9	35,6
67	GD 114	Asam Panjang	Suliki	26,3	73,2	36,0
68	GD 170	Simpang Padang	Suliki	25,7	73,0	35,2
69	GD 188	Pandam Gadang	Suliki	25,0	73,0	34,3
70	GD 163	Baruh Gunung 1	Anding	48,7	142,0	34,3

From the summary table above, we can see the results of the percentage of transformer loading in the Suliki KP work area. Based on the SPLN standard, a transformer that has a percentage of more than 80% is said to be overloaded. In the summary table, the percentage of loading exceeding 80 percent occurs in the GD 175 Kasiak transformer completed, thus the GD 175 Kasiak transformer is completed. Furthermore, the end voltage measurement was carried out on the transformer in the field using an ammeter. The calculation results show that the end voltage on the GD 175 Kasiak Rampung transformer is 177 Volts. According to PLN regulations (SPLN No.1 of 1995), one of the requirements for system reliability is that the voltage drop on the customer side must not be more than +5% -10% of its normal voltage. The calculation results for the GD 175 Kasiak Rampung end voltage are -10% of its normal voltage

The percentage calculation of the overloaded loads, and the measurement of the end voltage on the customer side exceeding the set standards indicate that the transformer requires repair efforts to maintain the continuity of electrical energy distribution and customer service quality. Actions that can be taken are by building an insert transformer so that excess loads can be transferred to a new insert transformer. The construction of insert transformers as an alternative solution to the problem is also supported by several complaints that occur to customers. In May 2024, there were 5 customer complaint reports regarding low voltage. In the construction of insert transformers, there are several Standard Operating Procedures (SOPs) that must be followed. The addition of insert transformers was previously submitted to PT PLN UP3 Payakumbuh, then after the administrative procedures were completed, construction in the field was carried out in the field. The construction of insert transformers in the field was carried out by the author in June 2024.

Based on the calculation results, it can be seen that the percentage of transformer loading after the transformer insertion is 45%; this figure is in accordance with applicable standards. The results of the end voltage measurement after the construction of the insert transformer are 227 volts; this figure is in accordance with applicable standards. Based on the results of calculations and measurements carried out by the author on the data of the GD 175 Kasiak Rampu Transformer, the percentage of loading and end voltage before and after the construction of the insert transformer can be seen in Figure 1.

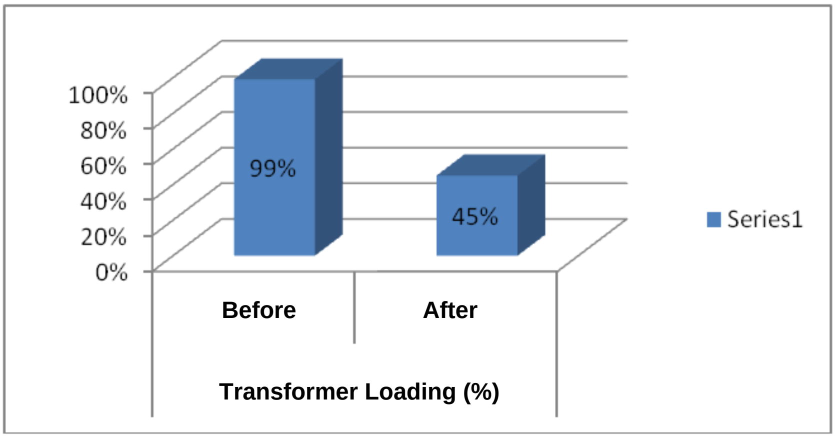

Figure 1. Comparison of loading percentage before and after installing the insert transformer

Based on the graph above, it can be seen that the percentage of loading of the GD 175 Kasiak transformer previously completed showed a value of 99%, which is where this figure exceeds the distribution transformer loading capacity, or it can be said that the transformer is in Overload status. After the construction of the insert transformer, the results showed that the transformer loading had been divided with the insert transformer and showed a figure of 45%. When compared to the applicable SPLN standards, the transformer loading percentage status can be said to be normal. This shows that the handling of excessive loading on the transformer which was overcome by building the insert transformer was successful. Transformer loading that is in accordance with this standard improves customer service.

The installation of the insert transformer has been able to increase the voltage level at the consumer end from 177 Volts to 227 Volts, as shown in the graph in Figure 2. Based on the graph in Figure 2, it can be seen that with the construction of the insert transformer on the GD 175 Kasiak Rampung transformer, it causes a change in the customer end voltage, namely at the beginning the voltage was measured at 177 Volts, after the insertion it became 277 Volts. Where this value is in accordance with the applicable SPLN standards.

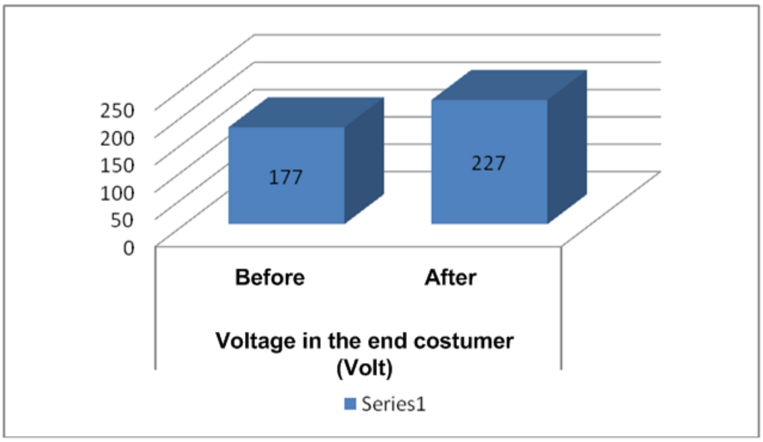

Figure 1. Comparison of the voltage at the end costumer before and after installing the insert transformer

4. CONCLUSION

Based on research on the Installation of Insert Transformers to Improve End Voltage at PT PLN ULP 50 Kota, it can be concluded that the results of the calculation of the percentage of loading of 108 transformers located in the area of PT PLN (Persero) ULP 50 Kota Service Office (KP) Suliki, there is 1 transformer, namely GD 175 Kasiak completed which is experiencing Overload, with a loading percentage of 99%. The voltage measurement on the customer end side shows a figure of 177 Volts. The loading percentage and voltage value do not comply with the applicable SPLN standards. Efforts to build insert transformers on transformers experiencing Overload are efforts made to optimize the quality of the transformer voltage and improve the voltage to customers. Insert transformers are added to serve excess loads on distribution transformers. The results of the calculation of the percentage of loading on the GD 175 Kasiak Completed transformer after the construction of the insert transformer shows a figure of 45% or is said to be normal and in accordance with standards. Furthermore, for the voltage at the customer, the measurement results show a figure of 277 Volts which is also in the standard category. The results of the comparative analysis before and after the construction of the insert transformer show that after the construction of the insert transformer, the problems that previously occurred in the loading of the transformer and the voltage at the customer can be overcome by the construction of the insert transformer. Furthermore, this effort brings many benefits, namely improving the quality of customer service, increasing electricity sales, reducing ENS if there is a maintenance transformer, and Improving the company's image.

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